

ZOOLOGY.—*Appalachian Cambalidae: Taxonomy and distribution (Diplopoda: Spirostreptida)*. RICHARD L. HOFFMAN, Blacksburg, Va.

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Although the American cambaloid millipeds, having been the subject of a careful treatise by H. F. Loomis in 1938, are in a more satisfactory taxonomic condition than most other groups of diplopods in this country, the examination of recently acquired material indicates a need for some nomenclatorial adjustments in the genus *Cambala*. Ideally such changes should be made in the body of a complete generic revision. Material is now being accumulated for a detailed study of *Cambala*, but the present scarcity of specimens of the very poorly known Ozarkian and Midwestern species will postpone its completion for an indefinite period of time. For this reason, it seems worthwhile to clear up the confusion of the large eastern species promptly, before additional synonymy accumulates in the literature.

The problem is one that can be settled on the basis of geographic distribution, and the present resolution of it is due in large measure to the interest and diligence of my friend Leslie Hubricht, collector of most of the existing material. The following treatment is based on 68 collections totaling well over 300 individual specimens of *Cambala*.

Prior to 1938 only two species of *Cambala* had been named: *annulata* (Say 1821), of the Atlantic coast region, and *minor* (Bollman, 1888), of the Interior Lowlands. In his monograph of the American cambaloids, Loomis showed, however, that in fact two well-marked species—easily recognizable by several structural characters apart from the male gonopods—occurred in the southeast within the range previously ascribed only to *annulata*.

Making what, on the basis of his limited material, was certainly a justifiable decision, Loomis restricted the name *annulata* to the population in which the peritremata are larger and more distinctly "pyriform" as stipulated in Say's original description. Of this species, Loomis had material from the mountains of eastern Tennessee and western North Carolina. For the other form—the

annulata of earlier workers—he proposed the new name *Cambala cristula*, an arrangement which has been accepted by all workers who have subsequently dealt with the group.

It is now apparent, however, on the basis of much subsequent field work, that the name *cristula* is based upon the common and widespread member of the genus, which ranges over much of eastern United States and which is apparently the only cambaloid occurring in the Atlantic Coastal Plain. On the other hand, the species which Loomis identified as *annulata* seems clearly to be confined to a narrow strip of high country making up the Iron and Unaka Mountain ranges of the southern Appalachians. Inasmuch as Say's excursion to Florida in 1818, during which the types of *annulata* were taken, was limited to the coastal area, it seems reasonable to assume that he would have collected the cambaloid known to occur there rather than a species of restricted range which is endemic to a region he never visited. The qualifying adjective "pyriform" used by Say in his description could equally well be applied to either of the species, although of course the peritremata of the montane species are much more accentuated and "pear-shaped."

This identification of the name *annulata* on the basis of geographical evidence occasions a certain amount of departure from existing nomenclature. For the present, the name *cristula* Loomis 1938 (type locality, Etowah, Tenn.) will have to be regarded a junior synonym of *annulata* Say 1821, with the reservation that it will be available should the trans-Appalachian segment of the *annulata* population be found subspecifically distinct from the typical form of the southern Atlantic Coastal Plain. The species which Loomis treated as *annulata* must now be provided with a new name.

For the present, with extended descriptions available in Loomis's valuable paper, it does not seem necessary to go into detail regarding comparative morphology, a matter which will be covered thoroughly in the

forthcoming generic revision. Only the salient diagnostic characters of the two Appalachian species are cited, and these two are readily separated from all other species by their large size as well as by details of the male genitalia. The two species under consideration may be distinguished from each other by numerous structural differences, of which some of the most conspicuous have been selected for the diagnostic comparison which follows.

It seems appropriate that the montane *Cambala* be named in honor of Mr. Hubricht, who although primarily concerned with the study of terrestrial gastropods has nonetheless secured more cambalids than have all other collectors combined, and it is largely through his efforts that the present treatment was possible.

1. Body very long and slender, 18 to 20 times as long as wide, and distinctly narrowed toward the anterior end; peritremata very pronounced, subconical in shape, and on fourth segment much larger than the dorsal crests; coxal plates of anterior gonopods distally acuminate and not concealed by the telopodites; coxal process of posterior gonopods long, slender, and simple, directed distad. *Cambala hubrichti*, n. sp.

Body distinctly stouter, 14 to 15 times as long as broad, the anterior segments not conspicuously narrowed; peritremata lower and more rounded, those of fourth segment not larger than the dorsal crests; coxal plates of anterior gonopods distally furcate and concealed by the incurved telopodites; coxal process of posterior gonopods short and stout, distally with several marginal dentations. *Cambala annulata* (Say)

***Cambala annulata* (Say)**

Julus annulatus Say, 1821, Journ. Acad. Nat. Sci. Philadelphia, **2**: 103.

Cambala lactarius Gray, 1832, in Griffith: "The Animal Kingdom, arranged in accordance with its organization by the Baron Cuvier . . . etc." **14**: pl. 135, fig. 2; **15**: 784 (misidentification of this species as *Julus lactarius* Say?).

Spiroboles annulatus Wood, 1865, Trans. Amer. Philos. Soc., n.s., **13**: 212.

Cambala annulata Cope, 1869, Proc. Amer. Philos. Soc. **11**: 181.—Bollman, 1887, Ann. New York Acad. Sci. **4**: 42; 1888, Proc. U. S. Nat. Mus. **11**: 339.—Chamberlin, 1918, Psyche **25**: 24.—Brimley, 1938, Insects of North Carolina: 498.—Chamberlin, 1947, Proc. Acad. Nat. Sci. Philadelphia **99**: 58.

Cambala cristula Loomis, 1938, Proc. U. S. Nat. Mus. **86**: 39, fig. 12; 1939, Bull. Mus. Comp. Zool. **86**: 168; 1943, Bull. Mus. Comp. Zool. **92**: 390.—Causey, 1952, Amer. Midl. Nat. **50**: 156.

Type specimen.—Female, in the British Museum (Natural History), presented by Thomas Say.

Type locality.—"Southern States" (Say), probably the coastal region between Charleston, S. C., and Jacksonville, Fla.

Distribution.—The range of this species, as known at present, is fairly extensive, extending from central Virginia south to northern Florida, west to Alabama, and north to the unglaciated parts of Ohio and Indiana.

Most of the localities plotted on the accompanying map are based on specimens in my collection. For records in the Coastal Plain, however, we must turn to the literature. In the original description of *Cambala cristula*, Loomis recorded specimens from Adams Run, Charleston County, South Carolina, and these millipeds are probably representative of the local population from which Say obtained his type specimen. Subsequently (1943) Loomis reported the species from Florida Caverns, north of Marianna, Jackson County, Fla., and from Kymulga Cave, 7 miles northwest of Childersburg, Talladega County, Ala., both collections being made by Leslie Hubricht. Other records of *annulata* from more western states, such as those of Bollman (1888) for Arkansas, and Chamberlin (1918) for Louisiana, are based upon other species of the genus, which have been subsequently described as new. Early records for Indiana by Bollman (1889) are based upon specimens of *Cambala minor*, but recent collections of *annulata* from Jefferson County, Indiana (Hubricht) and from Hocking County, Ohio (Bailey, Thomas, and Walker) establish that species north of the Ohio River in unglaciated territory.

Normally *annulata* is somewhat secretive in habits, occurring at the deepest levels of humus deposits or in the burrows of small mammals, and this fact has doubtless been responsible for the idea that the species is scarce. In the Appalachian region of southwest Virginia and western North Carolina, one can usually find *annulata* in abundance. For instance, in the vicinity of Blacksburg, Va., it is one of the most frequently encountered diplopods, and large collections attest to its prevalence in the western Piedmont area of North Carolina. Further to the north, however, the species becomes very scarce, for at Charlottesville Va., only two specimens could be found in nearly four years of local field work, and around Clifton Forge, in western Virginia, only

one has been collected in more than a decade of search. No material has been seen in extensive collections of millipeds made around Washington, D. C., and it seems possible that *annulata* does not extend farther north along the east coast than is now known.

Altitudinally, *annulata* ranges from sea level up to around 4000 feet at Highlands, N. C., and

Burkes Garden, Va. There appear to be no structural variations associated from the material from high elevations.

According to my field experience and Mr. Hubricht's collection data, *annulata* is most frequently found in rather dry upland oak woods, usually deep in humus but occasionally under partly buried logs and rotting stumps in dry lo-

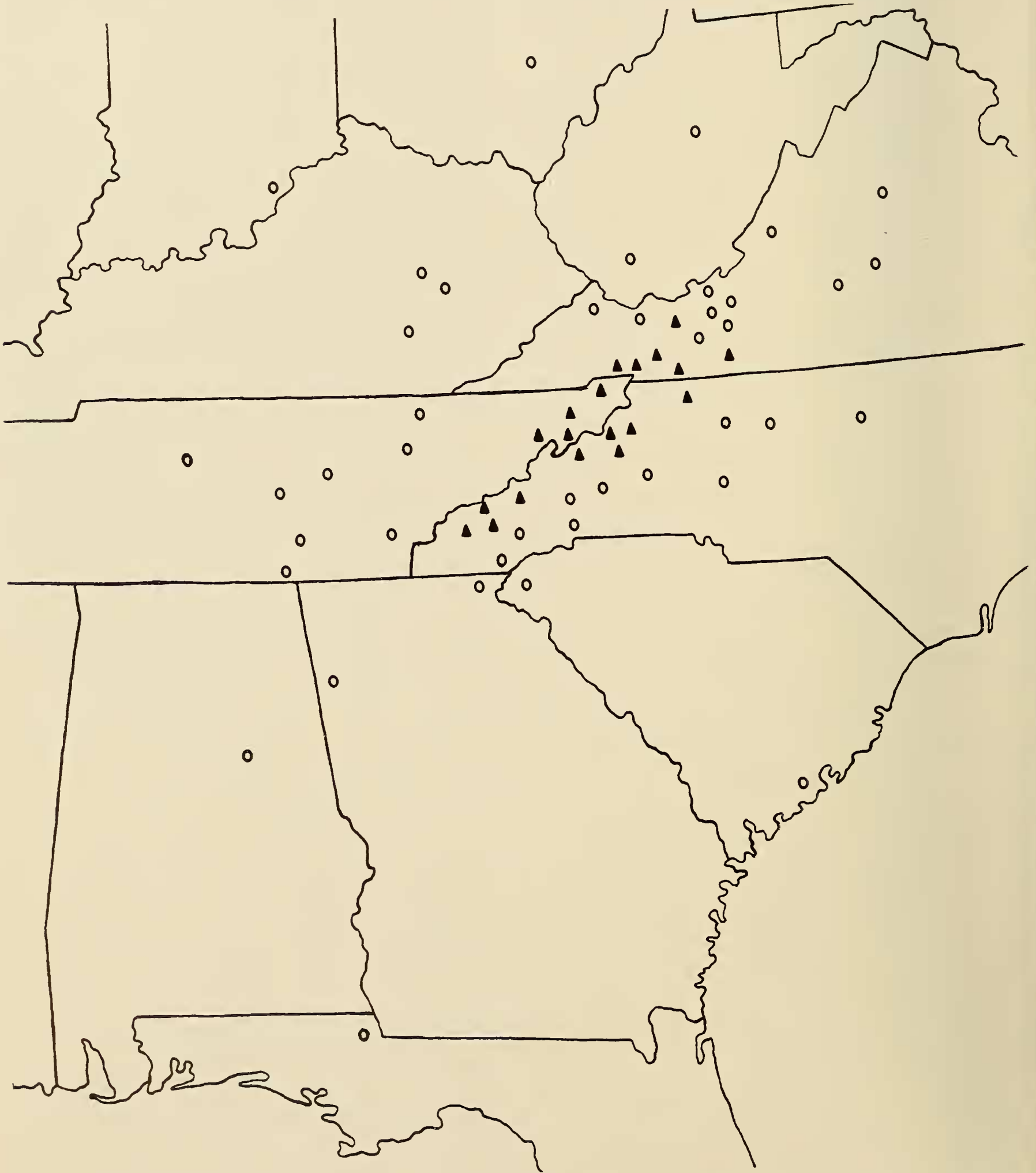


FIG. 1.—Southeastern United States, showing the distribution of *Cambala annulata* (Say) by open circles and of *Cambala hubrichti*, n. sp., by solid triangles. Records are based upon specimens personally examined and literature reports considered to be reliable.

cations. The species is gregarious, and usually several can be found together. Curiously enough, I have never discovered one in motion, even at night when nearly all other millipeds are active. When handled, specimens exhibit a peculiar slowness and stiffness of motion, and tend to curl into a loose spiral. Mated pairs have been found in May and June. The observed season of activity ranges from mid-February to November at Blacksburg, Va.

Cambala hubrichti, n. sp.

Cambala annulata (nec Say, 1821) Loomis, 1938, Proc. U. S. Nat. Mus. **86**: 37, fig. 11.—Chamberlin, 1952, Great Basin Nat. **12**:30.—Chamberlin and Hoffman, 1958, U. S. Nat. Mus. Bull. 212 (in press).

Type specimens.—Male holotype, U. S. Nat. Mus. (no. 2463), from a bluff along the Doe River, 1 mile northwest of Hampton, Carter County, Tenn., collected by Leslie Hubricht on May 3, 1951. Topo-paratypes from the same collection are deposited in the Zoologisch Museum, Amsterdam, and the Senckenberg Museum, Frankfurt a/M.

Diagnosis.—A very large species of *Cambala*, adults usually more than 50 mm in length, with a very strongly sculptured body about 18 to 20 times as long as its greatest diameter. From *C. annulata*, the only other species of equal size, this species is readily distinguished by the characters set forth in the preceding key couplet. In no other form of the genus are the peritremata of the 4th segment larger than the intervening dorsal crests.

This form has been adequately described and illustrated in the work of Loomis cited above, under the name *annulata*. Detailed consideration of the male genitalia is reserved for a future treatment.

Distribution.—*Cambala hubrichti* occurs over a narrow strip of mountainous terrain in the adjoining parts of southwest Virginia, eastern Tennessee, and western North Carolina. To the south, it has been taken as far as the Nantahala Gorge in Swain County, North Carolina; northward, to the Alleghenies in Wythe County, Virginia. The species is not, however, limited to high elevations, having been taken as low as 1,500 feet at several localities.

Specimens have been collected in the Balsams, the Iron Mountains, the Unacoi range, Holston Mountain, satellites of the Great Smokies, and

on the Blue Ridge itself northeast of Asheville. There are still no records, however, for the Black Mountains, although the species surely occurs there. All of the foregoing mountains and ranges are, physiographically, part of the Southern Section of the Blue Ridge Province.

Perhaps the most interesting locality for *hubrichti* is its northernmost, on Walker Mountain, a long and prominent mountain on the northwest side of the Tennessee River Valley and a component of the Ridge and Valley physiographic province. That a milliped species basically endemic to the southern Blue Ridge should occur more or less physiographically isolated at the northern extremity of its known range is of considerable zoogeographic interest. This instance reflects a distributional pattern recently established for the salamander *Plethodon jordani metcalfi* Brimley, as well as for species in other animal groups.

The evidence from both present-day physiography and known animal distribution indicates a former faunistic continuity from the Appalachian Plateau region of central West Virginia south and eastward to the parallel but offset mountains of the Southern Blue Ridge. The main trend of the former high country was clearly south across the region now included in southwest Virginia, and even today that region remains studded with isolated high peaks and ridges along the divide between the upper Tennessee and Kanawha river drainage systems.

Although the ranges of *annulata* and *hubrichti* overlap both horizontally and altitudinally at several areas, the species have not yet been taken together or in close proximity. Despite this apparent vicariation (which some systematists take, *per se*, to indicate subspecific relationship), the structural differences between these two large cambalids are so numerous as to leave no doubt that they are worthy of full specific rank. In the material examined thus far, I have seen no specimens which could be considered intermediate in any respect.

Records upon which the present concept of the species' range is based are listed as follows, the collections being made by me except as otherwise credited.

VIRGINIA. Wythe County: Big Bend Recreation Area, 4,000 feet. Big Walker Mountain about 10 miles northwest of Wytheville, August 6, 1956. Smyth County: Brushy Mountain, 5 miles east of

Marion, May 4 and August 20, 1954. Patrick County: Pinnacles of Dan, 6 miles southwest of Vesta, May 8, 1951 (W. B. Newman and R. L. Hoffman), also May 7, 1955 (W. T. Keeton, W. C. Lund, and R. L. Hoffman), also April 20, 1957 (R. E. Crabill, Jr., and R. L. Hoffman). Grayson County: Helton Creek, east side of Mount Rogers, 4,000 feet, June 19, 1950, and Peach Bottom Creek, 4 miles southwest of Independence, June 20, 1950 (J. A. Fowler and Hoffman); Comer's Rock Recreation Area, 2 miles northwest of Comer's Rock, June 15, 1950 (Leslie Hubricht). Washington County: Laurel Creek near Damascus, April 28, 1951 (Hubricht).

TENNESSEE. Johnson County: Holston Mountain, 2 miles west of Shady Valley, June 20, 1950 (Fowler and Hoffman). Carter County: Doe River bluff, 1 mile northwest of Hampton, May 3, 1951 (Hubricht). Unicoi County: Unaka Springs, southeast of Erwin, September 23, 1951, also June 2, 1952. Green County: Camp Creek, June 1947 (Mike Wright).

NORTH CAROLINA. Alleghany County: Air Bellows Gap, June 20, 1955 (Arnold VanPelt). Watauga County: 6 miles north of Boone, June 17, 1948 (Wright). Avery County: Route 221, east side of Grandfather Mountain, June 1, 1954; between Newland and Elk Park, May 20, 1956 (Keeton, Lund, and Hoffman). Mitchell County: 3 miles northwest of Spruce Pine, June 4, 1954. Yancey County: Route 19, 2 miles east of the State line, June 2, 1952. Jackson County: Soco Falls, 10 miles northeast of Cherokee, May 20, 1956 (Keeton, Lund, and Hoffman). Swain County: Nantahala Gorge, 8 miles southwest of Bryson City, May 6, 1951 (Hubricht).

In addition to the foregoing localities, the species has been reported by Chamberlin (1952) from Asheville, Buncombe County, N. C. The early record of Bollman (1888) for Balsam, Jackson County, N. C., is probably based upon specimens of *hubrichti*, but his specimens cannot at present be found for a verifying study. The material described by Loomis in 1938 was collected by O. F. Cook between Elizabethton and Roan Mountain, Tenn., probably within a few miles of the locality here selected as typical of this species.

ON THE ORDINAL POSITION OF THE CAMBALIDAE

The present allocation of the family Cambalidae to the Spirostreptida is at variance with the classification used in the forthcoming "Checklist of the Millipeds of North America" and requires some qualification. On the basis of recent studies of the comparative morphology in the cambaloid-spirostreptoid group of millipeds, I have found no basis for the recognition of the cambaloids as a separate order. Numerous annectant groups (such as the Choctellidae, Epinannolenidae, Physiostreptidae, and even Old World Cambalidae) constitute a network of intermediate conditions both in gonopod structure as well as configuration of the mouthparts. Some of this evidence is included in a report on the family Choctellidae, now in preparation, in which the order Spirostreptida is divided into three suborders: Cambalidea, Epinannolenidea, and Spirostreptidea.

REFERENCES

- BOLLMAN, CHARLES HARVEY. *A preliminary list of the Myriapoda of Arkansas, with descriptions of new species*. Ent. Amer. **4**: 1-8. 1888.
- . *Catalogue of the myriapods of Indiana*. Proc. U. S. Nat. Mus. **11**: 403-410. 1889.
- CHAMBERLIN, RALPH VARY. *Myriopods from Okefenokee Swamp, Ga., and from Natchitoches Parish, Louisiana*. Ann. Ent. Soc. Amer. **11**: 369-380. 1918.
- . *Further records and descriptions of American millipeds*. Great Basin Nat. **12**: 13-34, figs. 1-21. 1952.
- LOOMIS, HAROLD FREDERICK. *The cambaloid millipeds of the United States, including a family new to the fauna and new genera and species*. Proc. U. S. Nat. Mus. **86**: 27-66, figs. 10-21. 1938.
- SAY, THOMAS. *Description of the myriapodae of the United States*. Journ. Acad. Nat. Sci. Philadelphia **2**: 102-114. 1821.